

The Nature of Muscular Activity. DR. VON KRIES (*Arch. f. Anat. u. Phys.*, Supplement, 1886); HORSLEY & SCHAEFER (*Journ. of Phys.*, 1886).

The activity of the neuro-muscular system manifests itself in two ways, sensation and motion. These may be said to be the fundamental categories of neurology, and to them corresponds the division of the spinal cord into posterior and anterior halves. When we shall discover how the activity of the afferent nerve passes into that of the efferent nerve, the nervous system will have yielded up its most hidden secret. In the mean time, the physiologist must be satisfied with tracing as far as he can the nature of each of these activities separately. The problems of sensation have been largely given over to the psychologist, while physiological methods are best applicable to the study of motion.

The action of our nervous system, by which it causes a muscle to contract, is usually called innervation. The question that at once suggests itself is whether this innervation power has any limits. How rapidly can our will send down messages to the muscle and have these messages obeyed? Dr. von Kries has recently answered this question by recording the quickest possible movement which the finger can make. The finger was moved down and up as in striking a piano key; and as the object was to send out an impulse to bring the finger back as soon as possible after the down stroke was innervated, the minimum interval between two innervations was measured. First, let us speak of the time of the motion including a down and an up stroke. This was found to be from $\frac{1}{4}$ to $\frac{1}{11}$ of a second. If, instead of moving the finger voluntarily, it is caused to move by electric irritation of the muscle, the time is longer. This fact, that we can move voluntarily faster than when our muscle is contracted for us, is very important for the theory of muscle action. The movement does not of course stop abruptly when the finger has returned to its initial position; but only this portion of the movement is taken into account. The quickest such movement of the middle finger is .077 sec., of the hand .074 sec. It is rather curious that the extent of the movement has little effect on the time; the movements of medium length tend to take least time. Now the portion of this time from the beginning of the down stroke to the beginning of the up stroke, *i. e.*, the minimum innervation interval, is .061 sec., while the up stroke consumes only .017 of a second. The innervation interval is never shorter than $\frac{1}{20}$ of a second. In trilling on the piano, we have a good example of this sort of movement; and the fastest trill which ordinary music requires is not more than 13 to a second. Experts can keep up a short trill at nearly 20 per second. As regards movements of other pairs of antagonistic muscles, the time of the tongue movement is $\frac{1}{11}$ sec., of the foot and the jaw $\frac{1}{4}$ to $\frac{1}{5}$ sec.

If, however, such a movement is to be performed rhythmically for many times its speed must be diminished slightly. The finger can move in this way ten times per second (after practice), the jaw only 6.2, and the foot seven times per second.

If, instead of recording the resulting motion of the finger, we record the swellings of the contracting muscle, we gain a deeper insight into the nature of the contraction. We have, in the first place, from such a record, that the activity of the muscles continues after the motion is over and slowly falls back into its quiescent state; and secondly, the innervation and rhythms leave their trace in the curve of contraction. Normal muscular contraction is generally considered to be tetanic, that is, it is not a simple muscular twitch, but a series of maximal contractions. The curve that the swelling of the muscle unites is not a simple up stroke followed by a down stroke, but is composed of several smaller curves of this nature; it shows a rhythm, and a quite constant one, of about ten to twelve per second. It is to be understood that when we move the finger once, however slowly, the muscle gives a series of rapid twitches; what we think is a single innervation is really a manifold series. And in the shortest possible movement there are about four such waves in the curve of contraction, each such wave consumes about one-fifteenth of a second, the curve, of course, continuing after the resultant motion has gone into effect.

Finally, in rhythmical movements, the smaller waves of contraction become variable within wide limits to about forty per second.

These results are confirmed and supplemented by the recent experiments of Horsley and Schäfer. They excited electrically the cortex, the underlying motor fibres, and the motor area of the spinal cord of dogs and other animals, and found the same result from each of these modes of stimulation, viz., a contraction rhythm of about ten per second in the muscle. They varied the frequency of the stimulus from ten to fifty per second, but found that the rhythm of contraction was (generally) independent of the frequency of the stimulation. They found, too, that the same holds for voluntary and reflex motions as for these artificially excited ones.

The most natural explanation of these facts is that the innervations are surmounted in the motor cells of the cord (probably), and are re-issued from those cells at a constant rate of ten per second, no matter at what rate these cells receive these impressions.

Dr. Schäfer has applied the same method of study to voluntary contractions in man with the same result.

We see, then, that there is an innervation rhythm in the nervous system itself, which limits the rate of our quickest motions, and which determines, independently of our will, the activity of our muscles. What to our consciousness is a simple motor act, is really a series of contractions rhythmically exploding themselves at the rate of about ten per second.

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PATHOLOGY OF NERVOUS SYSTEM.

"Paralysis of the Isthmus of Panama. Beriberi, Kakke." PIERRE MARIE. (*Progrès Médical*, p. 168, 1887.)

The author, in this article, after briefly reviewing the paralytic